FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2000

BUDGET ACTIVITY: 2 PROGRAM ELEMENT: 0602234N
PROGRAM ELEMENT TITLE: MATERIALS AND RADIO FREQUENCY/ELECTRO-0PTICS/ INFRARED ELECTRONICS TECHNOLOGY

(U) COST: (Dollars in Thousands)

PROJECT NUMBER &	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
Materials and Radio Frequency/Electro-Optics/Infrared Electronics Technology									
	74,357	93,233	68,076	71,170	70,662	71,230	70,560	CONT.	CONT.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This Program Element (PE) provides Applied Research to support all Navy advanced weapon and platform system concepts and needs in the areas of materials and electronics technology. Developmental tasks address significant improvements in terms of affordability; performance; and reliability to effect transition of advanced technology to the Navy fleet. Development efforts are part of an integrated Department of Navy Science and Technology process managed by the Office of Naval Research.

(U) This PE develops enabling technologies to support most Joint Mission Areas, including:

- (U) Strike: advanced thermal management materials for most platforms to reduce weight and cost.
- (U) Littoral Warfare: acoustic signature reducing materials, torpedo warhead materials, vacuum electronics, solid state high power and low noise amplifiers.
- (U) Joint Surveillance: real-time targeting, connectivity, counter-jamming and deception, infrared (IR) sensors, broadband control components, and fiber optics technology.

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- (U) Space and Electronics Warfare/Intelligence (SEW/I): lightweight and radiation-hard satellite materials, radio frequency (RF) solid state devices.
- (U) Strategic Deterrence: advanced ballistic missile launcher materials, RF solid-state devices for secure communications.
- (U) Forward Presence issues: high temperature pavements for advanced aircraft, materials for condition based maintenance, RF solid state devices for secure communications, high power transmitters for precision strike.
- (U) Strategic Mobility: development of advanced distributed manufacturing capabilities and advanced long-life materials for repair of aircraft at sea, ultralight materials.

(U) In addition, this PE underpins the Readiness Joint Support Area and Support and Infrastructure Joint Support Area in the domains of affordability, environmental quality, and logistics. Programs include environmentally acceptable coatings for both aircraft and ships and the maintenance of the Navy pier and wharf infrastructure for surge capacity. This PE also contributes to lower system life-cycle costs through development of technologies that realize more compact, lighter weight electronic components.

(U) This PE supports the Office of the Secretary of Defense (OSD) Science and Technology (S&T) Investment Strategy in the following Future Joint Warfighting Capabilities: Real-Time Knowledge of the Enemy, Prompt Engagement of Regional Forces on Global Basis, Lower-End Actions, Space Control, and Countering Threat of Weapons of Mass Destruction; materials projects support affordable performance increases in radomes, infrared windows, advanced engines, and platform signature reduction to allow achievement of military objectives with minimum casualties and collateral damage; materials programs directly support lightweight, survivable satellite and spacecraft thermal control materials to positively affect the United States (U.S.) ability to control space usage. The PE is an integral part of the following Department of Defense (DoD) Technology Areas: Materials and Processes and Electronics Technology.

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(U) Due to the sheer volume of efforts included in the PE, the programs described in the Accomplishments and Plans sections are representative selections of the work included in the program.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the APPLIED RESEARCH Budget Activity because it investigates technological advances with possible applications towards solution of specific Naval problems, short of a major developmental effort.

(U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 1999 ACCOMPLISHMENTS:

- (U) SHORE FACILITIES MATERIALS. Shore Facilities Materials provides technology for the structure of piers, wharves, Naval/Marine Air Station runways, and other facilities required by naval logistics and operations, such as magazines and tank farms. The work is focused on demonstrating affordable materials to increase the life and reduce maintenance costs of such facilities.

  - (U) The potential durability of composite materials was demonstrated through characterization and material testing of upgrades of fiber reinforced concrete waterfront structures. Success of these evaluations will reduce the maintenance costs and provide increased lifetime for Naval waterfront facilities. These tests were conducted at Naval Facilities at San Diego and Port Hueneme, CA, and demonstrated the usefulness of fiber reinforced concrete.
  - (U) Test protocols and the desired mechanical characteristics of prestressed carbon fiber tendons were established in order to quantify the effects of material parameters on the durability of modular hybride composite/concrete structure for use in long life piers and wharves. These protocols were used to establish testing of specimens at pier sites in San Diego and Port Hueneme, CA.

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- (U) AIRBORNE MATERIALS. Airborne Materials provides technology for naval aircraft, including airframes, propulsion, and air weaponry. It is focused on those material issues associated with carrier landings, corrosion and affordability.
  - (U) Explored the benefits of beryllium-aluminum and beryllium-titanium alloys for aircraft applications.
  - (U) Demonstrated fabrication technology for compressor outer vane/diffuser using cast gamma titanium aluminides. Result: increased performance and decreased cost in Naval aircraft engines.
  - (U) Completed demonstration of 1500^{o}F Ni-turbine disk alloy. Has led to increased performance (thrust-to-weight) for Naval gas turbine engines.
  - (U) Transitioned Sempen touch-up kit (primer/topcoat) to Naval Aircraft Maintenance Groups; successfully flight-tested on F-18s and helicopters.
  - (U) Demonstrated non-toxic trivalent chromium coating for pre-treatment of aluminum alloys and post-treatment of anodized aluminum. Trivalent chromium is a possible replacement for hexavalent chromium which is restricted by the Environmental Protection Agency (EPA).
  - (U) Improved corrosion sensor systems for condition-based maintenance monitoring of aircraft corrosion by replacing hard-wired datalogger systems with a radio transceiver systems capable of downloading corrosion data to a lap-top computer. This provides needed technology for Navy implementation of condition based maintenance.
  - (U) Completed exploration of cost effective processing routes for high strength diamond material for applications such as infrared missile domes and windows.

- (U) SEABORNE MATERIALS. Seaborne Materials provides technology for all ship, submarine, and related materials needs, including hull materials, machinery materials, coatings of all types, and seaborne weapons materials. This work provides the enabling capabilities for reduced cost and maintenance, improved performance, and reliable operations.
  - (U) Initiated environmentally acceptable coating system development for non-magnetic ship hulls required for stealth and mine countermeasures.
  - (U) Developed corrosion sensor system for determining the protectiveness of coatings in ship ballast tanks for implementation of condition based maintenance.

- (U) Developed new LC-100 welding wire, with transition to prototype production heat for NSSN & CVN-77, to minimize costly preheat and eliminate hydrogen cracking for more affordable and reliable ship and submarine construction with advanced high strength steels.
- (U) Explored strength, fracture, and weldability characteristics of non-magnetic stainless steel for ship hull structures with reduced signature.
- (U) Demonstrated extraordinary dynamic fracture resistance in very low interstitial titanium alloy for ship and submarine application to enhance survivability.
- (U) Explored high strength, corrosion resistant fastener alloys for marine applications.
- (U) Completed development of HSLA-65 steel for naval construction/transition to CVN77.
- (U) Completed development and exploration of the plasma quench process to produce low cost titanium powder.

• (U) MISSILE/SPACE MATERIALS. Missile/Space Materials provides technology for tactical ballistic missile needs, including thermal management materials for power generation and protection, and spacecraft thermal straps and doublers. While this effort focuses on problems associated with naval systems, it is jointly planned and coordinated with Army, Air Force and Defense Advance Research Project Agency (DARPA) efforts.

- (U) Demonstrated fabrication technology for affordable and reliable low cost hybrid materials for reentry vehicle heatshield applications. Result: lower cost replacements for defunct heat shield materials.
- (U) Demonstrated the benefits of ceramic materials for protection of propulsion components and other high temperature impingement applications in terms of predictive models and material screening test development. Result: reduced cost and improved engine performance for Naval missiles.
- (U) Evaluated advanced ceramic materials in rocket environment. Result: higher operating temperatures and greater reliability for Naval missiles.

• (U) MULTI-MISSION MATERIALS. Multi-mission materials provides developing technologies for promising naval applications such as biomolecular materials for antifouling coatings on ships. It also supports materials technologies for naval

systems across a broad spectrum, such as laser eye and sensor protection as well as sensor/transducer materials for sonar and condition based maintenance applications.

- (U) Demonstrated a computer program to model non-linear optical materials in optical limiting devices for laser eye protection. Such materials have the potential for frequency agile protection for Marine Corps.
- (U) Demonstrated a system and controlling software for a reliable ultrasonic tomography that alleviates the problem of refraction to increase the ability to rapidly inspect aging platforms.
- (U) Demonstrated improved processing technology reducing the cost of microtubule materials and composites for advanced shipboard applications and transferred to industry.
- (U) Analyzed the impact of piezocrystals on torpedo guidance sonar transducers produced a design exhibiting 12dB source level increase and a bandwidth increase from 10 to 35 kHz in a transducer less than one-third the size and weight of present piezoceramic devices.
- (U) Demonstrated the use of nanostructured tungsten carbide cobalt (WC/Co) coatings was demonstrated by fabrication and testing of selected prototype components.
- (U) Developed techniques for fabrication of nanostructured ceramic and aluminum matrix composite coatings were carried out. Production of nanostructured feedstock materials was scaled to pilot plant capacity. Result: maintenance cost reduction due to repair versus replacement for ship and submarine machinery components.

- (U) RF SOLID STATE DEVICE AND CONTROL COMPONENTS. Provides for the generation, radiation, reception, control and processing of Ultra High Frequency (UHF), Very High Frequency (VHF), Microwave (MW), and Millimeter Wave (MMW) power for Navy all-weather radar, surveillance, reconnaissance, electronic warfare (EW), communications, and smart weapons systems. The technology developed cannot be obtained through Commercial Off the Shelf (COTS) as a result of the requirements placed on power, frequency, linearity, bandwidth, weight, and size. Beginning in fiscal year 1998 the Microelectronics thrust has been merged with RF Solid State and Control Components to highlight the increasing digital RF emphasis of Microelectronics.
  - (U) Continued to develop 80 kW W-band duplexer for Navy’s 94 GHz radar program.

- (U) Developed design parameters for heterojunction varactor for use in compact, high Q, tunable bandpass filters and oscillators for transmit/receive (T/R) module applications.
- (U) Continued to develop InGaP/GaAs heterojunction bipolar transistors for applications in pulsed Ka-band phased arrays for dual mode, electronic countermeasure resistant hyper-velocity strike weapon conformal apertures.
- (U) Demonstrated device technology for low power, low volt sub 500nm – 250nm CMOS/SiGe with T-gate structures in 50nm thick Thin Film Silicon-on-Sapphire (TFSOS). These devices, which have frequency performance in excess of 50 GHz, allow development of RF analog front end receiver, 16-bit, 125 megasamples/sec and 10-bit, 2.6 gigasamples/sec analog to digital (A/D) converters, for use in digital receiver (X-band)/electronic warfare(EW)/communication/signal intelligence.
- (U) Demonstrated the analog portion of low power, high-resolution 2 – 5 kilosamples/sec A/D converter for sonar, shallow water Anti Submarine Warfare (ASW) applications.
- (U) Demonstrated components of 16 bit, 125 megasamples/sec A/D converter for application to wide bandwidth digital ASW receiver to meet Navy multi-channel acoustic systems requirements.
- (U) Continued development of 25 channel Continuous Wavelet Transform circuit for EW signal identification applications.
- (U) Continued to develop 6.1 Angstrom materials for high frequency applications.
- (U) Demonstated components of 4-bit 10 gigasamples/sec A/D converter for application to wide bandwidth radar warning receiver (RWR) to meet Navy multi-channel EW system requirements.
- (U) Developed 14 watt Gallium Nitride (GaN) X-band amplifiers for high power transmitter applications.
- (U) Developed GaN heterojunction field effect power transistors for next generation electromagnetic (EM) power amplifiers.

- (U) VACUUM ELECTRONICS. Provides for the generation and reception of MW, MMW, and sub-millimeter wave power. The technology being developed is not available through COTS because of the power and size requirements.
  - (U) Developed high-power,high average power (10kw), moderate bandwidth (600 MHz) gyroklystron for Navy 94 GHz radar programs.

- (U) Continued to develop a 2 dimensional/3 dimensional (2D/3D) electron gun and collector design code for vacuum devices.
- (U) Developed an ultra-wide band vacuum power booster for EW applications.
- (U) Continued to develop a high-duty, wideband gyro-TWT to support radar and EW applications at millimeter-wavelengths.

- (U) EO/IR TECHNOLOGY. Provides for the development of IR focal plane arrays to detect targets against various backgrounds; RF photonics technology to increase the bandwidth and reduce the size/weight of phased arrays; and IR transmitting fibers for EW applications. The technology being developed is not available through COTS, which is primarily focused at 1.3-1.55um whereas Navy requires electro-optic devices and components in the threat bands of 2.0-2.5, 3.5-5, and 8-12um.
  - (U) Continued to develop a 256 x 256 adaptive infrared focal plane array (IRFPA).
  - (U) Continued to develop optical microwave link with external lithium niobate modulators at 20 GHz.
  - (U) Demonstrated 25mW photodetector at 8GHz for higher sensitivity remotable antennas; performed initial study of thermal effects on high power detectors with resultant new device design in fabrication.
  - (U) Continued to develop a 3 band IR detector to enhance performance against countermeasures and stealthy targets.
  - (U) Continued to develop mid-IR fibers with low loss region and improved fiber fabrication techniques achieving high tensile strength fibers.
  - (U) Continued to reduce fiber defects and optimized fiber preparation to achieve power damage threshold > 1.2 GW/cm^2.
  - (U) Continued development of broadband, high damage threshold anti-reflection (AR) coatings for 2 - 5 μm region.
  - (U) Continued to develop cabling techniques for ruggedized, thermally tolerant one-meter cables.
  - (U) Continued to evaluate InAs/InGaSb growth techniques.
  - (U) Continued to develop small pixel 2-color midwave Focal Plane Array (FPA) for missile threat warning applications and shipboard Infrared Search and Track (IRST).

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- (U) ADVANCED MULTIFUNCTIONAL RF SYSTEM SUPPORT TECHNOLOGY. With the advances that are currently being made in electronics there exists a strong opportunity to realize multifunctional systems that integrate the functions of radar, EW, and communications into a pair of transmit and receive apertures over a broad bandwidth. It should be noted that this program is in contrast to the Air Force (AF) and Joint Strike Fighter (JSF) programs in that it treats both the transmit and receive functions in separate apertures. This approach avoids the need for time allocation of different RF functions and therefore offers the opportunity for more massive integration of RF functions into the pair of apertures. As a result, this integrated thrust has been formed and the current program enhanced to capitalize upon ongoing and planned applied research to develop RF solid state and photonic devices. This program is coordinated with JSF and the AF and has an oversight group with representatives from Space and Warfare Systems Command (SPAWAR), Naval Air Systems Command (NAVAIR), Program Executive Office (PEO) DD-21, PEO Theater Air Defense/Surface Combatant (TAD/SC), Common Support Aircraft (CSA), N86 and N6. Specific efforts include:
  - (U) Continued to develop a continuous wave (CW) ultra broadband, ultra linear (cross modulation products 28 dbm below fundamental signal) compact amplifiers suitable for use in next generation wide area surveillance systems.
  - (U) Continued to develop a superconducting A/D capable of 19 bits of dynamic range over a 20 MHz spectrum for use in reducing background clutter in littoral warfare surveillance operations.
  - (U) Continued to develop an RF transmit and receive beamforming network for the generation of simultaneously multiple frequency independent RF beams capable of beamsteering over ± 60 degrees from boresight on transmit and receive with control structure that preserves a 500 MHz instantaneous RF bandwidth for each beam.
  - (U) Fabricated wide bandgap semiconductors and began testing of low parasitic bipolar microwave power amplifier.

2. FY 2000 Plan:

- (U) SHORE FACILITIES MATERIALS.
  - (U) Start tests on samples subjected to freeze/thaw cycles, oxidation, and photothermal conditions to ascertain their effects on the bond of carbon/epoxy to concrete.

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- (U) Conclude analysis and testing to characterize the bond of carbon fiber reinforced plastic (CFRP) rods and tendons in high strength lightweight concrete. Conclude testing and analysis of glass fiber reinforced plastic (GFRP) under environmental exposures and derive durability factors for use in design of waterfront structures.

- (U) AIRBORNE MATERIALS.
  - (U) Explore fabrication technology for improved single crystal/polycrstalline Ni compressor disks. This will result in improved performance and less weight in Naval aircraft engines.
  - (U) Explore feasibility of oxidation resistant Mo-Alloy w/2500^{o}F capability. This will result in revolutionary performance improvements in Naval aircraft engines.
  - (U) Evaluate radio activated corrosion sensor systems for condition based maintenance implementation on H-60 helicopters.
  - (U) Evaluate susceptibility to stress-corrosion cracking of aluminum alloy joints produced by friction stir welding. Friction stir welding eliminates need for fasteners in aircraft construction, resulting in weight saving.

- (U) SEABORNE MATERIALS.
  - (U) Explore improved anticorrosive coatings for non-magnetic ship hulls required for stealth and mine countermeasures.
  - (U) Evaluate corrosion sensors for ship ballast tanks for implementation of condition based maintenance.
  - (U) Explore centrifugal and sedimentation casting for superior durability/life extension of ship shafting and seals.
  - (U) Develop high strength, corrosion resistant fastener alloy for marine applications.
  - (U) Explore property/structure/weldability relationships for lower carbon higher strength/toughness steels.
  - (U) Identify materials upgrades for long life seawater valves to reduce total cost of ownership.
  - (U) Explore guided wave ultrasonics for detecting corrosion/erosion in shipboard piping without removing insulation for implementation of condition based maintenance.

- (U) Evaluate strength, fracture, and weldability characteristics of stainless steel and other nonmagnetic alloy for ship and submarine structures with reduced signature.
- (U) Design, fabricate and test improved fender system using fiber reinforced urethane composites.
- (U) Investigate fire resistance and low velocity impact damage of carbon reinforced polyurenthane as candidate lightweight, non-magnetic material for construction of ships for signature reduction.
- (U) Demonstrate new MIL-100S welding wire designed to enable more affordable and reliable welding of high strength steels in ship and submarine construction through reduction of preheat and elimination of hydrogen cracking for construction and maintenance cost reduction.
- (U) Develop improved models of deformation and fracture of hull materials, for incorporation into computer codes to simulate response of ship and submarine structural materials to underwater explosion, in cooperative program between U.S. and Germany.
- (U) Explore innovative, more affordable processes for improved welding of ship/submarine structural materials, including non-magnetic stainless steel to reduce signatures and provide mine counter measures.

- (U) MISSILE/SPACE MATERIALS.
  - (U) Investigate Refractory metal (Hf, Ta) spraying process for fabrication of low-cost metal nozzles which will increase performance and reduce cost in missile engines.
  - (U) Develop oxidation models for ceramic systems of interest (HfC, HfW, HfB2) which will result in improved performance and reduce development costs for missile propulsion systems.
  - (U) Investigate novel cost-reducing processing methods for carbon composite missile heat shields.

- (U) MULTI-MISSION MATERIALS.
  - (U) Explore new formulations of phthalocyanines that do not show performance degradation at high fluences (energy/area) for advanced laser eye and device protective devices.
  - (U) Demonstrate new laser technology to characterize hydraulic fluids and lubricants and predict machine condition.

- (U) Demonstrate the performance of single crystal piezoelectrics (high sensitivity-2 Octave Bandwidth) in high frequency ultrasonic imaging transducers.
- (U) Use of nanostructured oxide ceramic coatings will be demonstrated by fabrication and testing of selected components. Techniques for fabrication of nanostructured Ni-based alloy coatings will be developed for multi-mission applications.

- (U) RF SOLID STATE DEVICE AND CONTROL COMPONENTS.
  - (U) Demonstrate highly compact, high Q, tunable notch filter for T/R module applications.
  - (U) Demonstrate GaN heterojunction field effect power transistor for 6 - 18 GHz operation for next generation electric/magnet (E/M) magnetic power amplifiers.
  - (U) Continue the development of GaN based high electron mobility transistor (HEMT) in the 1 – 18 GHz spectrum and connected as class B, push-pull for maximum efficiency and linearity for ultra wideband microwave power module (MPM) applications.
  - (U) Demonstrate 25 watt GaN X-band amplifier for high power transmitter applications.
  - (U) Develop a programmable time delay hybrid circuit for improving co-site interference canceller accuracy over very high frequency (VHF) operation bandwidth.
  - (U) Demonstrate SiGe T-Gate structures with Ft, Fmax > 100 GHz and equal p/n channel Medal Oxide Semiconductor Field Effect Transistor (MOSFET) mobilities to minimize CMOS circuit area.
  - (U) Apply and transition the technology of Complementary Metal Oxide Silicon (CMOS) low voltage, low power sub 250nm – 100nm SiGe with T-gate structure in 50nm – 30nm TFSOS for the implementation (design, fabrication and demonstration) of K-band (40 GHz) low noise analog front-end receiver functions and 4 bit, 20 gigasamples/sec A/D converters using two time-interleaved 4 bit, 10 GSPS A/D converters.
  - (U) Demonstrate a 25 channel Continuous Wavelet Transform circuit for EW signal identification.
  - (U) Develop 6.1 Angstrom materials for ultra-low power, high frequency applications.

- (U) Develop very compact, high power density, reliable, and affordable Ka band heterojunction bipolar transistor (HBT)devices having InGaP/InGaAs emitter-base materials composition for all-weather multi-mode conformal array guidance weapon systems to combat small radar cross-section (RCS) low-flying anti-ship (and other anti-high value target) cruise missiles.

- (U) VACUUM ELECTRONICS.
  - (U) Develop an ultra-wideband microwave power MPM for EW applications.
  - (U) Develop vacuum power booster technology for a 2-D array MPM for phased array applications.
  - (U) Develop an airborne compatible gyroklystron with gridded electron gun for high pulse repetition frequency (PRF) radar to provide unambiguous Doppler at W band.
  - (U) Develop design for gridded electron beam gun for the airborne capable gyroklystron using 3D electron gun code.
  - (U) Develop 2D/3D electron gun and collector design codes for vacuum devices.
  - (U) Develop high brightness scandate cathode for high perveance traveling wave tubes (TWTs) to increase reliability through lower operating temperature.

- (U) EO/IR TECHNOLOGY.
  - (U) Demonstrate 3.3 V Pi modulator at 20 GHz and improved packaging.
  - (U) Develop optical microwave link with external lithium niobate modulators at 20 GHz.
  - (U) Develop 256x256 adaptive two color IRFPA for increased clutter and background rejection.
  - (U) Demonstrate a three color IR detector to enable discrimination against advanced countermeasures.
  - (U) Develop a small pixel color discriminating IRFPA for wide field of view shipboard IRST for the theatre missile defense interceptor applications and missile threat warning applications.
  - (U) Optimize fiber fabrication techniques to achieve goal of 0.1 dB/m loss in 2 - 5 μm region and proof-test fibers to goal of 50,000 psi for EW applications. Reduce AR coatings reflectance to 2% in 2 - 5 μm region. Improve optical

power damage threshold to achieve goal of 1.5 GW/cm2 in AR coated fibers. Develop cabling techniques for 10 m length cables which are ruggedized and meet system environmental specifications.
- (U) Evaluate InAs/InGaSb growth techniques.
- (U) Develop 6.1 Angstrom materials for high performance IR detection and mid IR lasers.

- (U) ADVANCED MULTIFUNCTIONAL RF SYSTEM SUPPORT TECHNOLOGY.
  - (U) Demonstrate moderate power CW ultra broadband (1 - 18 GHz), ultra linear (cross modulation products 28dbm below fundamental signal) compact amplifiers suitable for use in next generation multifunctional wide area surveillance systems and also suitable for use as drivers in microwave power modules.
  - (U) Develop low parasitic bipolar microwave power amplifier for the 1 - 5 GHz spectrum.
  - (U) Demonstrate critical components for a 100 GHz logic-derived microwave synthesizer for 1 - 5 GHz output.
  - (U) Select final approach to A/D converter with real-time adjustment of resolution vs. bandwidth and suitable for use with advanced multifunctional RF systems. Utilize 100 GHz capable digital technologies to develop alternative A/D converters each programmable to trade resolution for bandwidth and thus be usable at will for ship self defense or wide band signal interception.
  - (U) Continue the development of a multicomponent model for antenna isolation and coupling to assess options for minimizing interference and self-jamming of multifunction apertures.

3. FY 2001 Plan:

- (U) SHORE FACILITIES MATERIALS.
  - (U) Conduct laboratory tests to characterize system performance and durability of scaled hybrid composite/concrete components having integral fault monitoring systems.

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- (U) Develop an empirical basis defining relationships between material constituents and performance properties of high strength, lightweight concrete for marine applications.

- (U) AIRBORNE MATERIALS.
  - (U) Continue exploration of advanced turbine disk fabrication technology using single crystal and polycrystalline Ni alloys. This will result in improved performance in naval aircraft engines.
  - (U) Expand exploration of oxidation resistant Mo-Alloys with greater than 2500^{o}F capability. This will result in revolutionary engine performance.
  - (U) Explore thermal barrier coating technology for oxidation resistant Mo-Alloys to enhance operating temperature by at least 200 F.
  - (U) Identify cadmium replacement technologies to fleet to comply with EPA regulations.
  - (U) Evaluate radio activated corrosion sensors in P-3 operational aircraft for implementation of condition based maintenance.
  - (U) Evaluate corrosion prevention applique technology in operational carrier environments to reduce hazardous material disposal costs.

- (U) SEABORNE MATERIALS.
  - (U)Integrate composite and multifunctional technologies for reduced signature and weight in ship topside design.
  - (U) Develop innovative, more affordable processes for improved welding/joining of ship structural materials, including non-magnetic stainless steels to reduce signature and provide mine countermeasures.
  - (U) Develop centrifugal and sedimentation casting for superior durability/life extension of ship shafting, seals, and other machinery.
  - (U) Complete development of high strength fastener alloy for marine applications.
  - (U) Investigate advanced low carbon high strength steels for weldability and survivability.

- (U) Investigate non-magnetic alloys in regard to strength, fracture behavior, fabrication, and corrosion protection for ship hull application to reduce signature.
- (U) Develop improved fire-resistant, low-cost composite material systems to enhance fire-fighting capability.
- (U) Develop prediction capability for underwater explosion loaded hull structural material with rupture to improve warfighting ability.
- (U) Continue evaluation of environmentally acceptable coatings technology for non-magnetic ship hulls required for stealth and mine countermeasures.
- (U) Continue evaluation of corrosion sensors in ballast tanks of operational ships to enable implementation of condition based maintenance.
- (U) Evaluate upgraded seawater valves in operational ship systems to reduce total cost of ownership.
- (U) Transition guided wave ultrasonics corrosion/erosion detection technology to fleet to enable implementation of condition based maintenance.

- (U) MISSILE/SPACE MATERIALS.
  - (U) Explore advanced processes for fabrication of components for missile engines for cost reduction and improved reliability.
  - (U) Expand and refine oxidation models for high performance/low cost missile propulsion systems.
  - (U) Continue exploration of advanced carbon/carbon processing for advanced missile heat shields.

- (U) MULTI-MISSION MATERIALS.
  - (U) Demonstrate the effectiveness of metal nanoshell technology for advanced laser eye protective devices.
  - (U) Synthesize new phthalocyanines with improved optical limiting properties.
  - (U) Demonstrate high strain capability (more than triple conventional piezoceramic devices) in a multilayer actuator fabricated from relaxor piezoelectric crystals.

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- (U) The use of nanostructured ceramic, Ni- and Al-based alloy, and cermet coatings will be qualified and transitioned to shipboard use for repair and refurbishment of existing equipment and for life extension of new equipment.

- (U) RF SOLID STATE DEVICE AND CONTROL COMPONENTS.
  - (U) Determine maximum CW power output for a GaN heterojunction field effect power transistor for 6 - 18 GHz operation for next generation EM power amplifiers.
  - (U) Demonstrate GaN based high electron mobility transistor (HEMT) in the 1 - 18 GHz spectrum and connected as class B, push-pull for maximum efficiency and linearity.
  - (U) Develop MPM compatible solid-state control components for phased array applications.
  - (U) Establish tunable band-reject active filter concept with prototype demonstration.
  - (U) Demonstrate low power high performance of logic circuits based on 6.1A materials.
  - (U) Demonstrate high power density Ka-band InGaP/InGaAs HBTS for applications in all-weather multi-mode conformal array missile guidance systems to combat low RCS, low-flying cruise missiles.
  - (U) Develop a functional multi-element coupled-cavity phased-array module and demonstrate power amplification, digital phase shifting and radiated power beam steering.

- (U) VACUUM ELECTRONICS.
  - (U) Develop an efficient, highly linear MPM for digital and wideband communications systems applications.
  - (U) Develop an asymmetric depressed collector using 3-D design code to provide for enhanced array compactness.
  - (U) Develop non-thermionic cathodes based on wide bandgap materials for the low-emittance electron guns required for next generation millimeter-wavelength amplifiers.
  - (U) Develop wideband gyro-TWT for airborne and shipboard non-cooperative target recognition (NCTR), combat ID, and theater ballistic missile defense discrimination applications.
  - (U) Continue coupled cavity TWT and electron design code development to achieve first-pass design success in vacuum electronic amplifiers.

FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2000

BUDGET ACTIVITY: 2 PROGRAM ELEMENT: 0602234N
PROGRAM ELEMENT TITLE: MATERIALS AND RADIO FREQUENCY/ELECTRO-0PTICS/ INFRARED ELECTRONICS TECHNOLOGY

- (U) EO/IR TECHNOLOGY.
  - (U) Demonstrate and transition 256 x 256 adaptive IRFPA to Naval Air Warfare Center (NAWC) China Lake.
  - (U) Demonstrate 1024 x 640 readout for the 2 color small pixel IRFPA.
  - (U) Develop a three color IRFPA to enable discrimination against advanced countermeasures.
  - (U) Develop a small pixel two color discriminating IRFPA.
  - (U) Develop integrated balanced photoreceivers with high current to suppress noise by > 15 dB.
  - (U) Develop heterodyne transmitters for increased power handling and noise suppression.
  - (U) Develop reconfigurable routing for shared utilization of platform broadband data.
  - (U) Develop broadband wavelength division multiplexing for analog and digital signal processing.
  - (U) Develop low loss fiber with loss < 1dB/m for long wave infrared region (8 - 12 μm) and develop technology to make coherent bundles to couple to IR focal plane array detectors for infrared countermeasures (IRCM) applications.
  - (U) Demonstrate performance potential of detectors and lasers based on 6.1 Angstrom materials.

- (U) ADVANCED MULTIFUNCTIONAL RF SYSTEM SUPPORT TECHNOLOGY.
  - (U) Demonstrate 3 Watt output CW ultra broadband (1 - 18 GHz), ultra linear (cross modulation products 28dbm below fundamental signal) compact amplifiers suitable for use in next generation multifunctional wide area surveillance systems and also suitable for use as drivers in microwave power modules.
  - (U) Determine maximum power output obtainable for a low parasitic bipolar microwave power amplifier for the microwave synthesizer for 1 - 5 GHz output with internal phase and frequency modulated signals.
  - (U) Demonstrate an A/D converter with real-time adjustment of resolution vs bandwidth and suitable for use with advanced multifunctional RF systems to provide a minimum of 500 MHz bandwidth and 9 bits of resolution.
  - (U) Demonstrate a compact, ultra low phase noise source of pure tones at 10, 94, and 190 GHz as a clocking source for the Advanced Multifunction Radio Frequency System (AMRFS) high speed digital signal processing circuits and true time delay beam steering network.

FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2000

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B. (U) PROGRAM CHANGE SUMMARY:

	FY 1999	FY 2000	FY 2001
(U) FY 2000 President's Budget:	87,698	77,957	82,631
(U) Appropriated Value		104,107	
(U) FY 1999 SBIR/STTR Transfer	-1,281		
(U) Execution Adjustments	-2,532		
(U) Inflation Adjustment	-399		
(U) Program Adjustment			-13,307
(U) Comparability Adjustment to 0602232N:	-9,129	-10,357	
(U) Congressional Plus-Ups		26,150	
(U) Congressional Rescission		-517	
(U) Various Rate Adjustments:			-1,248
(U) FY 2001 PRESBUDG Submission:	74,357	93,233	68,076

(U) CHANGE SUMMARY EXPLANATION:

(U) Schedule: Not applicable
(U) Technical: Not applicable.

C. (U) OTHER PROGRAM FUNDING SUMMARY:

(U) RELATED RDT&E:

FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2000

BUDGET ACTIVITY: 2 PROGRAM ELEMENT: 0602234N
PROGRAM ELEMENT TITLE: MATERIALS AND RADIO FREQUENCY/ELECTRO-0PTICS/ INFRARED ELECTRONICS TECHNOLOGY

(U) PEs 0601102A, 0601102F, 0601153N (Defense Research Sciences)
(U) PEs 0602105A, 0602102F, (Materials Technology)
(U) PE 0602705A, (Electronics and Electronic Devices)
(U) PE 0602204F, (Aerospace Avionics)
(U) PE 0602709A (Night Vision Technology)
(U) PE 0602702F (Command, Control and Communications))
(U) PE 0602303A (Missile Technology)
(U) PE 0602601A (Combat Vehicle and Automotive Technology)
(U) PE 0602786A (Logistics Technology)
(U) PE 0602111N (Air and Surface Launched Weapons Technology)
(U) PE 0602121N (Ship, Submarine and Logistics Technology)
(U) PE 0602122N (Aircraft Technology)
(U) PE 0602314N (Undersea Warfare Surveillance Technology)

D. (U) SCHEDULE PROFILE: Not applicable